Navy Personnel Research and Development Center
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Field Survey of Videoteletraining Systems in Public Education, Industry, and the Military

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13. ABSTRACT *(Maximum 200 words)*

The objective of the project was to find more cost-effective ways to train Navy personnel who are geographically remote from existing instructional resources. A field survey was conducted of a representative sample of 13 sites in public education, industry, and the military which are currently using videoteletraining (VTT) to deliver remote-site instruction. The systems surveyed are of one of three types: (1) open training networks, (2) closed training networks, and (3) conferencing networks. The majority of training networks use one-way video with two-way audio although the use of two-way video is increasing. There appears to be a trend for VTT systems to expand in the form of VTT consortia. Poor quality audio is a problem shared by many VTT systems.

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FOREWORD

This technical report describes work conducted by the Navy Personnel Research and Development Center as part of the Communication Networks in Training (CNIT) project on remote-site training. The CNIT project is one part of the Schoolhouse Training product line and falls under the Personnel and Training Technology (NP2A) Block of the 6.2 Mission Support Technology Program Element 0602233N (Work Unit RM33T23.02). The work was performed under the sponsorship of the Office of Naval Technology. Communication technology is rapidly evolving, and researchers, trainers, and educators are making great strides in applying it to many instructional settings.

The objective of the project is to find more cost-effective ways to train personnel who are geographically remote from training resources. The project has been exploring the use of new communication technologies to export classroom training to geographically-remote students. Among these technologies are video, computer networking, facsimile, and other media. This technical report summarizes on-site observations and interviews conducted at 13 representative videoteletraining systems currently in use in public education, industry, and the military. The report describes the design and training usage of each system and discusses the application of videoteletraining in Navy training.

The recommendations in this technical report are intended for use by the Chief of Naval Education and Training and Chief of Naval Operations (OP-11) in developing policy for the application of advanced communication technology to Navy training.

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SUMMARY

Objective

The overall objective of the project is to find more cost-effective ways to train Navy personnel who are geographically remote from existing instructional resources. This technical report describes how VTT systems are being used in public education, industry, and the military to provide training to geographically remote students.

Problem and Background

A requirement exists to train Navy personnel who are geographically remote from instructional resources. Evolving communication technologies have the potential to reduce the impact of geography on training. For example, developments in compressed digital television have made it increasingly cost-effective and promising for training applications. Satellite and wide-bandwidth land line links enable users at different locations to share training experiences and resources and essentially shrink global geography. The solution to the Navy's remote-site training problem lies in understanding the future course of these technologies and harnessing them for use.

Approach

A representative sample of VTT sites was selected, an interview protocol was developed, and project personnel made site visits during which they surveyed VTT sites by conducting structured interviews and toured VTT facilities.

Findings

Systems surveyed included both training and conferencing networks. These networks were either open (able to transmit to and receive from other networks), or closed (operating autonomously, without links to other networks). The majority of training networks use one-way video with two-way audio, but the use of two-way video is increasing. Research on VTT pertaining to interactivity and the use of two-way video on VTT networks is currently insufficient to give clear answers to how much interactivity is needed or how it should be provided for particular situations. Existing networks seem to be expanding in size and number of communication channels. There appears to be a trend for VTT systems to expand in the form of VTT consortia. This trend may be attributable to recent developments in video compression techniques, which increase the number of channels possible within a given communication bandwidth. The most consistently reported problem with VTT systems was poor quality audio.

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INTRODUCTION

Problem and Background

A requirement exists to train Navy personnel who are geographically remote from training resources. This requirement exists throughout the Navy, but is perhaps most obvious for personnel aboard ships at sea. Shipboard training is limited by available training resources and the skills of shipboard trainers. By necessity, personnel are periodically assigned to formal schools to receive training they cannot receive aboard ship. The remote-site training requirement also exists in the Navy reserves. Reservists typically belong to small detachments, widely dispersed geographically, with limited training resources, few qualified trainers, and little time to train. The requirement to overcome geographic remoteness in training delivery is widespread and exists in the civilian as well as the military world.

Evolving communication technologies have the potential to reduce the impact of geography on training. For example, developments in compressed, digital television have made it increasingly cost-effective and promising for training applications. Satellite and wide-bandwidth land line links enable users at different locations to share training experiences and resources and essentially shrink global geography.

The solution to the Navy's remote-site training problem lies in the proper selection and use of new communication and instructional technologies. In general, these technologies are costly and constantly changing; new technologies appear regularly. Proponents of one technology or another proclaim the virtues of their favorite. Many technologies are being used on a regular basis, others in demonstration projects. Investigators are exploring strengths and limitations, cost-effectiveness, and other dimensions governing suitability for different applications. Unfortunately, there is no road map to follow to determine which technology is "best" in a particular application today and which will be "best" next week, next year, or 10 years from now. The Communication Networks in Training (CNIT) project at the Navy Personnel Research and Development Center (NPRDC) is exploring different technologies, research and development projects, and the Navy's training problems in order to gain a better understanding of which technologies hold the greatest potential for future use in the Navy.

Objective

The primary objective of the CNIT project is to find more cost-effective ways to train personnel who are geographically remote from training resources. This objective is being addressed along four different tracks:

1. Assess the applicability of new communication technologies to the solution of Navy training problems caused by geographic dispersal of training.

2. Design, develop, and evaluate an experimental, computer-based instructional support network.

3. Design, develop, and evaluate an experimental, two-way videoteletraining (VTT) system.

4. Conduct experimental studies in a VTT laboratory to investigate the impact of instructional and system design variables on remote training effectiveness and acceptance by users.

This technical report describes a field survey performed as a prelude to the experimental studies on track four. During FY88 and FY89, work was performed on tracks 1, 2, and 3; other technical reports describe this earlier work (see Simpson, 1989; Simpson, 1990; Simpson & Pugh, 1990; and Simpson, Pugh, & Parchman, 1990.

The survey was conducted to obtain current baseline information about operational VTT systems (i.e., the state of the art of VTT technology; extent of use within public education, industry, and the military; prevailing instructional philosophies and practices; system design features; and problems encountered by system users). Survey findings support work on CNIT project track four. Further work on track 4 will be reported in the future.

APPROACH

Overview

This section describes the approach in terms of site selection, survey instrument design, and data collection.

Site Selection

Our goal was to select a small but representative sample of operational VTT systems. There are hundreds of such systems in existence, mainly in public education, and we could not survey them all. Hence, we had to be selective in choosing sites to survey in depth. We began by developing an initial list of operational systems within the continental United States that we might potentially visit. The list was based on articles in telecommunications and training journals and conference proceedings, on personal contacts, and from sites profiled in recent surveys by the Texas Higher Education Coordinating Board (1986) and U.S. Congress, Office of Technology Assessment (1989). The list was narrowed down by contacting personnel at potential sites via telephone, briefing them on the purpose of the intended survey, and obtaining detailed descriptions of facilities and training being conducted and determining willingness of site personnel to participate in the survey.

The final selection of sites to survey was made based on the representativeness standard. The survey includes 13 systems in public educational institutions, private industry, and the military. The various systems use several different types of transmission media (e.g., satellite, land line, microwave), both analog and compressed-bandwidth digital transmission, and one-way and two-way video. Most of the systems surveyed are used primarily for instructional delivery, but some are also used for conferencing.

Survey Instrument Design

A written questionnaire was developed to guide on-site interviews and observations. General topics covered in the questionnaire are VTT system design, network architecture, description of instruction/training program, system technical support, description of system evaluations and

related research, and cost data. The complete survey instrument is shown in the appendix of this report. The instrument includes short-answer questions, space for making drawings (e.g., of network diagrams), and space for making notes.

Data Collection

Three project personnel made site visits to collect survey data. Travel itineraries were planned to enable each interviewer to visit a series of sites within a particular geographic area during a time period of approximately 2 weeks. Site personnel were then contacted, visits were coordinated and scheduled, and site visits were made.

Prior to site visits, we sent the point of contact at each site a list of interview topics to alert them to the type of information the survey was intended to obtain.

Each site was visited by one project team member. The point of contact was contacted and an interview was conducted with a subject matter expert at the site; these interviews typically lasted about 2 hours. In some cases, additional personnel at the site were interviewed to answer questions. Sites were toured and observations were made of ongoing educational/training processes. VTT system documentation was obtained, if available. This documentation typically included system descriptions, course schedules, copies of papers delivered at conferences, and various other publications relating to the system. Site visits typically were completed within a single day.

FINDINGS

Overview

Table 1 lists the sites visited, and characterizes them in terms of four factors: Primary Use, Network Type, External Links, and Video Communication Type.

Table 1

Site Descriptive Characteristics

	Primary Use		Network Type		External Links		Video Comm. Type	
Site	Training	Conference	Open	Closed	Downlinks	Uplinks	One-way	Two-way
1. SEN	X	-	-	X	-	-	X	-
2. Westcott	X	-	-	X	-	-	X	-
3. Navy Elect Schl	X	-	-	X	-	-	-	X
4. U. Wisc	X	-	X	-	X	X	X	-
5. SDSU	X	-	X	-	X	X	X	-
6. OSU	X	-	X	-	X	X	X	X
7. U. Mo	X	-	X	-	X	X	X	X
8. U. Maine	X	-	X	-	X	-	X	X
9. U. Vermont	X	-	X	-	X	-	X	X
10. WSU	X	-	X	-	X	X	X	X
11. EDS	-	X	-	X	-	-	X	-
12. ABC	-	X	-	X	-	-	X	X
13. DCTN	-	X	-	X	-	-	-	X

Note. X indicates the presence of features or use. A feature such as two-way video may exist on only part of a network.

Primary Use is either Training or Conferencing. Nine of the systems surveyed are training networks, three are conferencing networks. This is a descriptive rather than a functional distinction. In general, a conferencing network can be used for training, though the ones we surveyed were seldom or never used for this purpose.

Network Type is either Open or Closed. An Open network may transmit to or receive from other networks. A Closed network operates autonomously, without links to other networks. Note that this is a system architectural distinction and does not refer to signal encryption or confidentiality. All of the open networks surveyed are associated with public educational institutions.

External Links are the types of connections the network has to other networks. A closed network has no connections. An open network may be able to transmit communications (via an Uplink), receive communications (via a Downlink), or both transmit and receive. The most common type of link is an earth station permitting the system to communicate via satellite.

Video Communication Type may be One-way or Two-way. Most networks have one-way video links to most of their sites, and they use an audio return link to establish two-way communication. Some networks use only audio return links from several sites but also have two-way video links between primary sites. The networks are illustrated and described in greater depth in the Network Architectures section of this report.

In what follows, each VTT site is described separately, first in overview and then in terms of its VTT System Description (network architecture, site design characteristics), Instruction/ Training (nature of curricula, students, and other aspects of instruction), and Evaluation (any evaluations or other current research at the site).

U.S. Army Satellite Education Network

Overview

The Satellite Education Network (SEN) is operated by the U.S. Army Logistics Management College at Ft. Lee, Virginia. The mission of the college is to improve acquisition management, logistics support, logistics operations, and related functions through the education of Department of Defense, Army, and Army Materiel Command personnel. Courses offered on the network support this mission, although the network is being used, increasingly, for additional purposes as well. The system broadcasts approximately 4 hours per day, 30 weeks per year. One-way VTT instruction is supplemented by instruction with personal computer-based audiographics (i.e., digitized images stored on a site's computer are keyed by timing signals received from the originating site over telephone lines).

The SEN in major respects resembles a commercial broadcasting facility. Conventional technology is used (i.e., unencrypted, analog, one-way video and two-way audio (return audio via telephone)). Downlink sites purchase capital equipment at a cost of about $8,000 and subscribe to the SEN service for about $300 per month. Because of its low operating costs for users, the SEN has proved to be highly cost-effective.

VTT System Description

The SEN has a single satellite uplink at Ft. Lee and 58 downlinks throughout the continental United States. At Ft. Lee, fully equipped studios are provided with professional quality cameras, sound, lighting, special effects, etc., and they are manned by trained, full-time personnel. At the receiving sites, a facilitator turns equipment on and off, and provides such support as handing out printed materials during instructional delivery. Each receiving site is equipped with a 46" rear projection monitor showing the incoming signal, a computer on which graphics can be presented, and push to talk microphones, which allow students to talk to the instructor via an audio bridge. Instruction is delivered via TV for approximately 4 hours per day and via audiographics for 2 hours per day. **Audiographics** (a term used for the technology which delivers graphic information over low bandwidth phone lines) is also used during TV courses as a means of delivering high quality graphics to the remote site.

Audiographics are used for approximately one-third of instructional delivery. Diskettes are mailed to the remote site and can be controlled remotely via the phone link while the instructor's voice is presented over a loudspeaker. Students can talk back to the instructor via the audio bridge.

VTT Instruction/Training

During 1989, 24 classes were conducted for approximately 5000 students. No students are present at the originating site. A typical broadcast is received by seven or eight sites, with each site having a maximum of about 30 students. During FY90, the Logistics Management College was offering 16 courses and the Army Management College was offering seven courses. Courses ranged in length from 1 day to 3 weeks. Cost analyses were performed which estimate that the SEN reduces the cost of training a student to 27 percent of that for providing resident training.

Evaluation Overview

The SEN was evaluated by gathering student opinion and class performance data. Results show that student opinion ratings are slightly lower for SEN classes than for their resident equivalents. Scores on examinations did not differ significantly from those of equivalent resident courses.

Westcott Communications

Overview

Westcott is a full-service television production company, which produces programs for distribution on two networks having a total of over 7000 downlinks. A Westcott-owned enterprise, Automotive Sales Today Network (ASTN), provides sales and motivational training to personnel at automobile dealerships. Westcott owns and operates the Law Enforcement Television Network (LETN), which provides information and training to subscriber law enforcement agencies. Westcott also provides conferences or training sessions for clients on an ad hoc basis.

VTT System Description

Westcott programs for the two networks originate at a satellite uplink in Carrolton, Texas. There are more than 5100 downlinks on ASTN and more than 1500 downlinks on LETN. The

VTT System Description

Westcott programs for the two networks originate at a satellite uplink in Carrolton, Texas. There are more than 5100 downlinks on ASTN and more than 1500 downlinks on LETN. The studios at Carrolton are equipped with professional-quality cameras, sound, lighting, etc., and are staffed by trained, full-time personnel. The transmitted signal is Ku-band, analog, encrypted with Scientific-Atlantic B-MAC devices.

Individual subscribers are responsible for providing the appropriate facilities and equipment for receiving ASTN programs. Westcott gives new subscribers a list recommending the right equipment to purchase. Each subscriber must obtain a Scientific-Atlanta B-MAC decoder in order to unscramble the encrypted signal.

VTT Instruction/Training

Westcott tailors its programming to meet the needs of the clients subscribing to a particular network. In the case of the automotive network, professionals in marketing and management are hired to deliver sales training and give presentations to increase motivation. These programs are taped and rebroadcast when needed later.

There are two types of programs on LETN: Information/news programs, and training programs. Professional news people present the information/news programs live for the first showing, and the shows are taped for rebroadcast later in the day. Law enforcement officers are the instructors for the training programs, which are all prerecorded. These law enforcement instructors are required to submit their lesson plans, scripts, and instructional materials to LETN for approval. A single training session is limited to 24 minutes or less. If the training session requires a demonstration, Westcott will produce the demonstration using its equipment and staff.

Evaluation Overview

Westcott conducts periodic surveys to assess production quality. Westcott personnel state that surveys show that students have generally positive attitudes toward their system.

Navy Electronic Schoolhouse Network

Overview

The Commander Training Atlantic (COMTRALANT) Electronic Schoolhouse Network is based at Fleet Combat Training Center, Atlantic (FCTCLANT), and has been operational since early 1989. The network links five different sites by satellite. The network is regarded as experimental, but a preliminary implementation plan calls for expansion of the network, in stages, to provide coverage throughout the rest of the continental United States.

VTT System Description

The network is based at Dam Neck, VA, from which it is controlled and from which most instruction originates. Sites are linked via satellite. Each site can originate and receive video and

Classrooms are equipped with fixed cameras (on instructor, on students, downward-viewing graphics) and a small number of sound-activated microphones. The instructor wears a clip-on microphone.

VTT Instruction/Training

Teletraining has been used to deliver about two dozen different courses to several hundred students. Receiving classrooms have a maximum of 25 students; classes have been broadcast to up to 100 students. The majority of instruction has been on lecture-based courses lasting less than a week.

Evaluation Overview

An evaluation conducted by the Center for Naval Analyses indicates that differences between final grades of students at remote and originating sites are not "practically significant," and that there is a potential for training costs to be reduced by using VTT (Rupinski & Stoloff, 1990). The project received funding for FY90 and is expected to continue, with further development, in the future (Snowden, 1989; Mahnke, 1989).

University of Wisconsin

Overview

The University of Wisconsin (UW) has used electronic media for distance education for more than 20 years. The institution's early experience in this area was audio conferencing with no video component. Today, UW-Madison has a variety of electronic resources for providing education to remote students including VTT. However, its early success with telephone conferencing influences its distance education efforts. About 95 percent of the hours spent for electronic delivery of remote education from UW-Madison involve audio conferencing without motion video.

VTT System Description

The VTT system at UW-Madison uses one-way video and permits return audio via telephone. Satellite signals (C-band and Ku-band), microwave, and cable are all used for linking remote sites to the system. Instructional Television Fixed Service (ITFS) is used to deliver VTT classes in the Madison area. UW-Madison also uplinks engineering courses via satellite to the National Technological University (NTU), and can reach 300 or more sites via the NTU network. UW-Madison is also in the process of joining other universities in forming AG*SAT, a consortium to provide satellite-based education in agriculture.

The originating classroom is located in the studio of a public broadcasting station. Studio and control room are fully equipped and eight or more technical personnel are required to produce a VTT class (i.e., producer, lighting director, audio engineer, camera crew, etc.). The instructor works with the producer and video crew to create a professional-quality production.

UW-Madison makes extensive use of audio conferencing supported by computer-based audiographics for distance education, using it, for example, to deliver fully-accredited engineering courses to remote locations at a low cost. Originating classrooms for such courses are studios

UW-Madison makes extensive use of audio conferencing supported by computer-based audiographics for distance education, using it, for example, to deliver fully-accredited engineering courses to remote locations at a low cost. Originating classrooms for such courses are studios equipped with telephone conferencing equipment and audiographics workstation consisting of personal computer, high-resolution monitor, graphics pad, scanner, video camera (for still shots), and laser printer. The audiographics instructor sends audio and presents graphs and other still pictures to remote classes. Receiving classrooms are equipped with loudspeakers to hear the instructor and push-to-talk microphones to speak, as well as a graphics tablet for sending graphics to the instructor. The university has demonstrated that audiographics can effectively deliver distance education on technical subjects at relatively low cost. The technology may be used alone or together with VTT. University personnel contend that audio (particularly when supported by audiographics) is a low cost and instructionally-effective technology that should be considered before committing to the high cost of VTT. Audiographics can also be an important adjunct to the VTT classroom.

VTT Instruction/Training

UW-Madison offers telecourses in agriculture, engineering, child development, educational psychology, and other subjects.

Evaluation Overview

A major effort at UW-Madison is the formative evaluation of technology for distance education without motion video. The audiographics system described above grew out of this research.

San Diego State University

Overview

San Diego State University (SDSU) is part of the 19 campus California State University System. SDSU uses a one-way video, two-way audio VTT system to provide continuing education courses to employees at various work sites in the San Diego area via a closed network called PROFNET. SDSU also broadcasts instructional programming to the public via commercial cable TV.

VTT System Description

SDSU's VTT facilities are co-located with a public broadcasting station on the SDSU campus. PROFNET teleconferences are televised either from SDSU's broadcasting studio or downloaded from another source, such as the National University Teleconferencing Network, for rebroadcast on PROFNET. The VTT classroom will seat about 30 students and is equipped with broadcast quality cameras (for instructor, class, and lectern), microphones (for students and instructor), and video monitors. An operator in a separate room remotely controls all equipment. PROFNET subscribers provide the facilities and equipment necessary for receiving the programs.

SDSU is developing distance education in other media as well as VTT (e.g., BESTNET is a computer network which transmits graphics, data, and voice).

VTT Instruction/Training

PROFNET programming is primarily in engineering, computer science, and business courses and subscribers are generally users of high technology. For example, Naval Ocean Systems Center (NOSC) subscribes to courses in control systems, artificial intelligence, and microprocessor design.

Evaluation Overview

SDSU recently conducted an evaluation of PROFNET. One important finding was that students did not perceive live interaction to be a critical aspect of the instruction they received. As a result of this finding, researchers at SDSU are exploring the use of videotaped instruction.

Oklahoma State University

Overview

Oklahoma State University (OSU) sponsors Educational Television Services (ETS) for the purpose of providing a wide range of programming services to the university and business communities in Oklahoma and its neighboring states. In order to bring science, mathematics, and language to hundreds of K-12 schools in rural communities, the university provides facilities and support for the Arts and Sciences Teleconferencing Service (ASTS). When Oklahoma joined in forming the Midlands Consortium of the Star Schools Project, ASTS became a key component for building the extended system for distance education. OSU is the primary facility of the National University Teleconference Network (NUTN). The Star Schools Project, Midlands Consortium, and NUTN are described in greater detail in the Alternative VTT System Architecture section of this report.

VTT System Description

The Oklahoma State University VTT system is managed from Stillwater, Oklahoma. A land-line connects Stillwater to Tulsa and Oklahoma City, enabling full-duplex (2-way), compressed video to be transmitted at a data rate of 768 kilobits per second among these sites. Instruction can originate from any of these three sites. Stillwater has three broadcast studios with a full-service master control room. More than 250 sites receive Star Schools programming. Video is broadcast one-way. As many as 16 incoming phone lines can be handled simultaneously on audio bridges. Subscribers are responsible for acquiring the facilities and equipment for their own site based on an OSU-provided list of recommended equipment.

The OSU originating classroom is set up in a fully-equipped broadcast studio. Equipment includes three high quality video cameras, four 26" monitors, two 9" monitors to aid the instructor, instructor's lapel microphone, and the three suspended microphones for the class. Facsimile machine and VCR are also available.

Stillwater uses microwave for local transmissions. Two microwave channels are available for on-campus programming, and a third is available to transmit to the community. OSU VTT is unencrypted and can send and receive both C-band and Ku-band. Analog transmission is used internally but video transmissions among major campuses uses digital signals.

VTT Instruction/Training

OSU broadcasts high school VTT courses in language, mathematics, science, government, and economics. Laboratory sessions in courses such as chemistry are presented as pretaped demonstrations. The Midlands Consortium conducts teleseminars aimed at teacher improvement.

OSU provides VTT programming to NUTN. NUTN teleconferences are short (1 or 2 day) in such fields as management, child development, minority recruitment, boss-secretary relationships, and aging.

Evaluation Overview

A formal evaluation has been conducted as part of the Star Schools Project. Results have not become available in time to be summarized in this report.

University of Maine

Overview

The Community College of Maine/Telecommunications System, operated by the University of Maine system, provides access throughout the state to university and community college services. Two-thirds of the state's population lives beyond reasonable commuting distance from university or technical college campuses and the state had ranked 50th in the percentage of its adults participating in higher education; the community college was devised to serve the needs of these remote learners. Seven university campuses are connected by an interactive television system to community college centers, technical colleges, Maine Maritime Academy, and selected high schools. Inter-campus links are via fiber optic lines, and these links extend to outlying sites via ITFS. The system is used to distribute college and high school courses via interactive television and for teleconferencing. The state intends to link all its high schools into the system by 1992. The system, activated in fall of 1989, currently delivers approximately 90 courses to 58 locations and 2500 students yearly. The majority of instructional delivery is 1-way video, 2-way audio; conferences and some graduate courses involve 2-way video.

VTT System Description

The Maine network is based at Augusta, from which it is controlled and from which most instruction originates. Instruction can also be originated from any of the other seven university campuses, and programs can be distributed state-wide or regionally. The service linking campuses consists of a three-channel duplex DS-3 (i.e., 45 megabit), two audio channels, two 19.2 kilobaud data channels and one T1 (i.e., 1.54 megabit) data channel, with three additional T1 channels available. Each DS-3 is used to send full motion compressed video and audio between sites and provides an answer back audio link from remote sites.

equipped with a camera on instructor, on classes, and in an overhead downward-pointing position to pick up graphics. The instructor is equipped with a clip-on cordless microphone. Classroom audio is picked up by a small number of ceiling microphones whose level is controlled by the technician.

VTT Instruction/Training

The Community College of Maine offers a range of high school, college-level, and graduate courses, which are broadcast throughout the day, 6 days a week. Twenty-eight university faculty members conduct the courses. Approximately 40 college-level courses are offered per semester. The Augusta campus coordinates most academic support for the classes, with a staff that distributes course handouts, exams, and other materials.

Evaluation Overview

The Maine system was formally evaluated in the fall of 1989 by the University of Southern Maine Testing and Assessment Center. A full range of attitude measures was gathered, as well as course grades. Attitudes of students toward instructional television were, in general, positive. There was no significant difference in academic performance between students taking courses via instructional television and those attending live classes.

University of Missouri, Kansas City

Overview

The University of Missouri Video Network (UMVN) was formed to meet the training and educational needs of the community, business, and industry in the Kansas City area. Courses delivered over UMVN may originate from campuses at Kansas City, Columbia, or Rolla. Interactive video is available at the four main campuses. Corporate clients in the Kansas City metropolitan area are able to receive one-way video instruction for employees at their work sites.

VTT System Description

The backbone of UMVN currently consists of four nodes interconnected by leased T1 lines. The site for network management is at Kansas City. Each site is capable of sending and receiving compressed video and audio signals so that classrooms at any of the four campuses are fully interactive. National or international scope can be provided to the network by uplinking or downlinking satellite programs on Ku-band. To serve the Kansas City metropolitan area, there is a three-channel ITFS microwave capability which makes programming available to commercial clients in the area. Video equipment in the campus classrooms is controlled remotely by an operator. There are four cameras per classroom: overhead, on the class, and two on instructor. Classrooms are equipped with four 25 inch monitors, and two 9 inch high-definition monitors for each pair of students in the class. These small monitors generally get input from the overhead camera and are particularly useful for displaying detailed materials. There are two directional microphones at the front of each class, but dissatisfaction with audio quality caused this arrangement to be reconsidered.

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VTT Instruction/Training

UMVN provides VTT in computer science, engineering, management, pharmacology, and nursing. These graduate and non-credit classes are of particular interest to professionals who are working toward career advancement.

Evaluation Overview

UMVN has gathered survey data on student attitudes. The main finding was that students were positive about using the VTT system.

University of Vermont

Overview

The University of Vermont oversees Vermont Interactive Television (VIT), a statewide telecommunications system developed during the last 4 years in a partnership among education, business, and government. VIT is funded by state government with some support from private industry and is used for instructional delivery and conferencing by public education, government, and private entities that include colleges, non-profit groups, state agencies, high schools, teacher training organizations, and businesses. The system was developed to serve these diverse needs in a state where winter road access is often difficult. Its design goal is to provide VIT access within 25 miles of any location in the state. VIT became operational in late 1988, and is regarded by the university as an experimental system whose potential uses are still being explored; interested parties may use the system, as time allows, at low cost.

VTT System Description

VIT currently consists of a five-point network whose hub is at Randolph center. Each site is capable of originating and sending compressed, fully-interactive video and audio. The five points in the network may be interconnected in any configuration, but a particular site may only receive video from one other site at a time; the receiving site can select which site it wants to see. The system also has satellite downlinks, and can provide a satellite feed throughout the network;. The sites are interconnected with leased T1 lines. Instruction originates from classrooms where students are present; audio and video equipment are controlled remotely by a technician in a separate room. At key originating sites, each classroom is equipped with a camera on instructor, on classes, and in an overhead, downward-pointing position to pick up graphics. At secondary classrooms, a single manually-operated camera is used. The instructor wears a clip-on microphone. Classroom audio is picked up by a small number of free-standing, voice-activated floor microphones.

VTT Instruction/Training

The system is presently being used to deliver a broad range of credit and non-credit courses to its various users. The Winter/Spring schedule lists five college-level courses, nine industrial courses, two high school classes, and 24 special events. Courses and events originate from all sites.

Evaluation Overview

Vermont State College personnel gathered rating information from users and technical problem information from system technicians. In general, users found the medium acceptable, though there were numerous complaints about audio quality. No performance data were gathered, and no comparisons were made between video versus live instruction.

Washington State University

Overview

Washington State University (WSU) has campuses at Pullman (main campus), Spokane, Tri-Cities, and Vancouver. These sites are distant from one another and the agrarian land between campuses is sparsely populated. Washington State University uses VTT both to disseminate education to rural areas away from any WSU site, and also to provide interactive education among the campuses. To carry out these functions, two different television systems are used (i.e., WHETS, satellite-based VTT), although they can be linked and sometimes interact.

VTT System Description

The first part of the WSU video system is the Washington Higher Education Telecommunication System (WHETS). WHETS is a microwave-based telecommunications system which interconnects the four WSU campuses, and also makes connections to the University of Washington in Seattle, the University of Idaho in Moscow, Idaho, and to Gonzaga University in Spokane, Washington. The system permits two-way video and two-way audio communications among locations. The signal is currently analog, but will eventually be converted to digital to increase channel capacity to provide for future growth.

In Spokane, the WHETS system can deliver courses to various industrial sites in the area via ITFS. These industrial sites can receive but not send video signals--they are able to both send and receive audio signals.

The classrooms have seating capacities between about 40 and 80 students. Classrooms have one or two cameras in the back to cover the instructor, a camera in the front to cover students, and an overhead camera to pick up instructor notes and graphics. There are usually two monitors at the front of the class showing the active participant, and other monitors at the back of the class and at the podium allow the instructor to view other classes, to adjust notes on the podium, etc. The instructor wears a lavalier microphone and there are voice-activated desktop microphones for every two students.

The second part of the WSU video system is satellite-based VTT system using one-way video with a telephone-based return audio link. This system is used mainly to provide agricultural

information to the Washington state farming community. WSU is in the process of joining AG*SAT, a consortium being formed for the dissemination of agricultural information via satellite.

VTT Instruction/Training

WHETS carries 35 different upper division and graduate courses in such topics as business management, mathematics, and engineering. The majority of courses are intended for the working professional. There are 107.5 hours of class productions and 10 hours of administrative teleconferences per week. Classes are fully accredited and lead to degrees such as the MBA.

Evaluation Overview

Evaluation by an outside body concluded that the system was working well and that there were cost benefits to using and expanding WHETS. Students and instructors suggested improvements, but were generally positive about WHETS. The state legislature has responded to the positive review by granting funds of approximately 3 million dollars to expand the system.

Electronic Data Systems, Inc.

Overview

Electronic Data Systems (EDS) is an international corporation with considerable need for on-going training. It uses its own corporate video network to broadcast special events and to disseminate announcements, although it does not use this network to conduct routine training. EDS routinely works with a company specializing in VTT to produce and broadcast programs for them as it has found this less costly than doing the work in-house.

VTT System Description

The EDS video network has one uplink in Dallas, Texas, and approximately 200 downlinks throughout the continental United States. Transmission is one-way and encrypted with a Scientific Atlanta B-MAC device. Return audio is provided via 800-prefix telephone lines feeding into an audio bridge. The network operates about 12 hours per month.

EDS currently operates a hybrid land-line/satellite data transfer network that will eventually become available for disseminating distance education. Current plans are to develop and integrate text and graphics data transmission, videodisk technology, and audio conferencing to meet the need to train geographically-dispersed personnel.

VTT Instruction/Training

EDS has a corporate plan to provide continuing education courses to all employees who wish to participate. Anticipated classes are in management, computer systems, data systems, and other continuing education subjects. Many of these courses are currently presented with live instruction; however, the cost of travel has caused EDS management to look for economical means of producing distance education.

Evaluation Overview

EDS is conducting research toward finding and using technology to increase training efficiency. Results of this research are not available outside of EDS at this time.

ABC, Inc.

Overview

"ABC Inc." is a pseudonym for a large, multifaceted corporate retailer that requested that its name not be revealed. The site surveyed is a corporate division that provides communication services to company subsidiaries involved in retail sales, insurance, and banking. It employs a video communications network for executive conferences, upper-level management communications with the work force, and for training activities. The network covers the continental United States. The main purpose of the system is to maintain good communication within the corporation; training is a small though significant part of this task.

VTT System Description

The ABC communications system is a hybrid. Its backbone is a two-way, digital, 768 Kbps (kilobits per second) compressed videoteleconferencing system linking 43 locations via satellite and T1 land lines within the continental United States. A Compression Labs, Inc., encryption algorithm is used to privatize communications. An additional network is connected to the backbone to permit one-way video and two-way audio communication, with return audio via telephone.

ABC, Inc., uses a common room design in each of the 43 conferencing sites. Each room is approximately 20 ft. by 30 ft, carpeted, and sound conditioned. Conferees sit around a triangular table in the center of the room, where they can view a video screen and their picture can be captured by a video camera. There is also seating in the back of the room for non-participants. Two professional-quality video cameras with different lenses are located in the front of the room. One camera is used for conferencing, the other for one-way video transmission to receive only sites. Audio is picked up by a single, continuously live omnidirectional microphone in the center of the conference table. There are three rear projection screens at the front of the room: 4 ft. x 4 ft. color graphics/slide (left), 6 ft. by 3 ft. for conference participants (center), and 4 ft. by 4 ft. high-resolution graphics (right). The room also contains various devices for displaying visual aids, such as high-resolution scanner, laser printer, and VCR.

Equipment is maintained by a contractor, scheduled by secretarial staff, and operated by the conference moderator via a simple control panel (equipment operation is taught in a 1-hour session before the conference begins). The moderator's control panel controls camera direction, audio level, VCR, and other equipment.

Any of the 43 conferencing sites can originate one-way video after first selecting the appropriate camera and converting from digital to analog video signal feed.

Receiving sites for one-way video are usually at one of the retail outlets. The video equipment at receiving sites is nonstandardized, consisting of whatever monitors, speakers, etc., are available in the store's stock.

VTT Instruction/Training

Courses offered on the one-way video part of the system are typically 1- or 2-hour product training courses and are directed at sales personnel. Approximately 900 employees participate in each training session.

Courses offered on the two-way video system include electronic mail, voice-mail, management development, and business writing. Courses are typically made available to middle management and have a small number of students (7-15) in each classroom.

Evaluation Overview

ABC, Inc., has not conducted any evaluations or other research relating to VTT.

Defense Commercial Telecommunications Network (DCTN)

Overview

The Defense Commercial Telecommunications Network (DCTN) is a secure conferencing network used by the Department of Defense (DoD) and is being developed, under contract, by American Telephone and Telegraph Corporation. It is intended for use by senior DoD military and civilian personnel, and is not seeing significant use for training, although it could be used for this purpose. The DCTN currently consists of approximately 100 sites throughout the continental United States whose connectivity depends mainly on fiber optic lines. Further expansion of the DCTN requires growth in the fiber optic network, which is occurring slowly. The DCTN is growing with demands for its services, but at present covers limited geography and is expensive to use. For example, the monthly cost to link two sites within its existing matrix is $12,000 per site--$24,000 per month. Though this cost will undoubtedly drop as more users subscribe and the capital costs of the initial installation are amortized, it would appear to be prohibitively expensive to use the DCTN for training delivery for the foreseeable future. It appears that DCTN will be used primarily for videoteleconferencing rather than VTT.

VTT System Description

The DCTN may be conceptualized as a large network which may be configured into various subnetworks, each consisting of a series of designated DCTN sites. When configured as subnetworks, these sites may communicate with each other using fully-duplexed, compressed, encrypted video and audio.

Each DCTN site is equipped with remotely operated cameras (for conferees and downward-viewing for graphics), sound activated microphones, and large, high quality video monitors. Sites are spacious, well equipped, comfortable, and operated by professional audio-video personnel. DCTN sites may, in general, be regarded as the model of how conferencing facilities should be designed; their cost is typically in the neighborhood of one-half million dollars.

Instruction/Training

Little training is being conducted using the DCTN.

Evaluation Overview

No research related to VTT is being conducted; no evaluation data have been made available.

ALTERNATIVE VTT SYSTEM ARCHITECTURES

Overview

The Findings section distinguished between Open and Closed networks. The present section explores this distinction in greater depth by describing some common architectures of both types of networks. Two common architectures of closed networks are (1) one-way video from a single transmitting site to many receiving sites (Figure 1) and (2) multi-site two-way video network (Figure 2). A network with both two-way video and two-way audio links is characterized as a "full-duplex" network. The networks differ in architecture, but both operate autonomously, without links to other networks.

Closed networks can be converted to open networks by adding a link to an external network. Three common architectures of open networks are (1) one-way video from a single transmitting site, with link to an external network (Figures 3a, 3b); (2) multi-site two-way video network, with link to external network (Figures 4a, 4b); and (3) hybrid network with a mixture of internal one-way and two-way video links.

Several of the sites surveyed are open networks; all of these had downlinks, and most also had uplinks (see Table 1). Many of the open networks belong to consortia and conferencing networks, enabling them to tap resources outside their own local network (e.g., share programs with other networks).

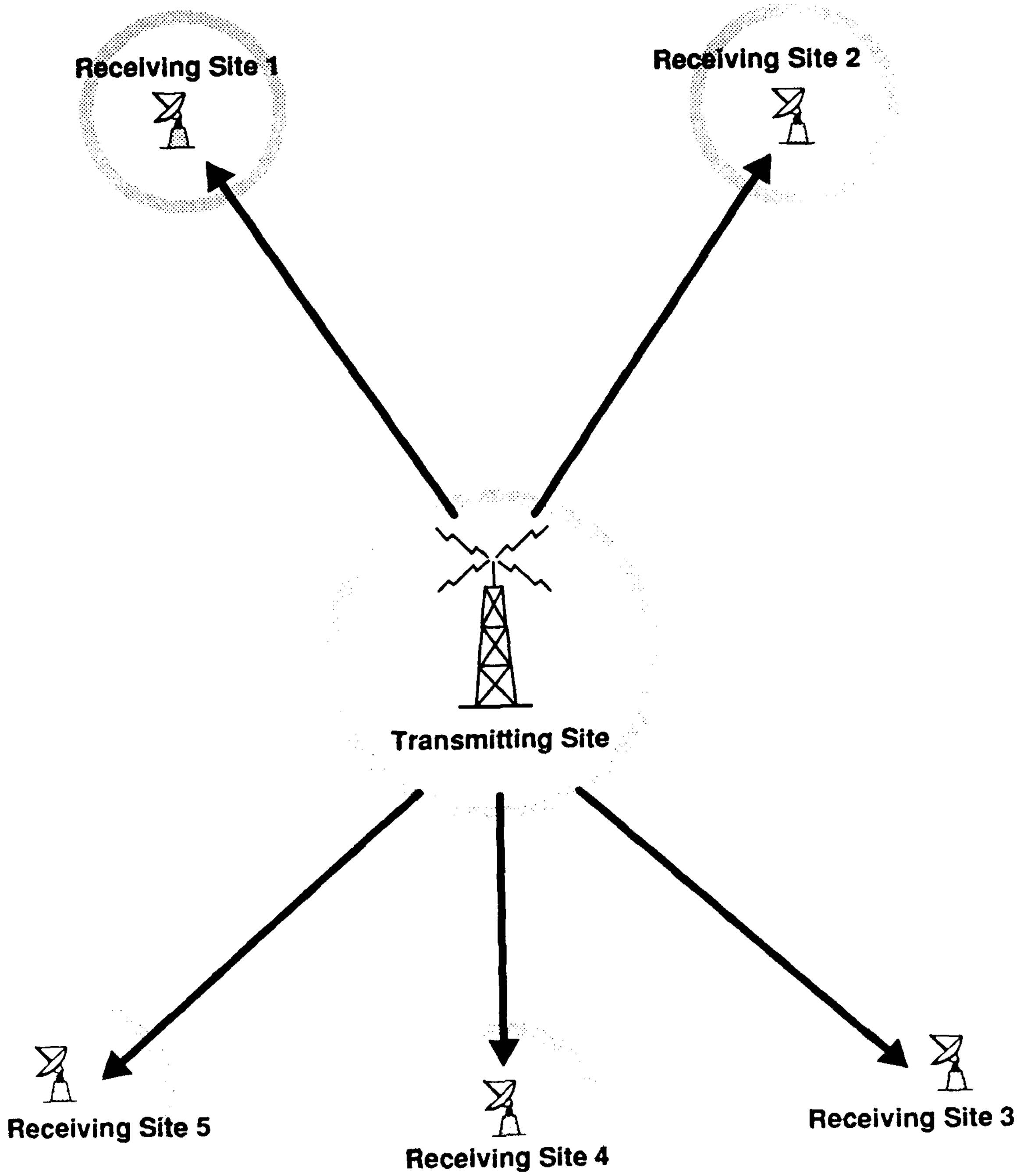

Figure 1. Architecture of closed network with single transmitting site and many receiving sites.

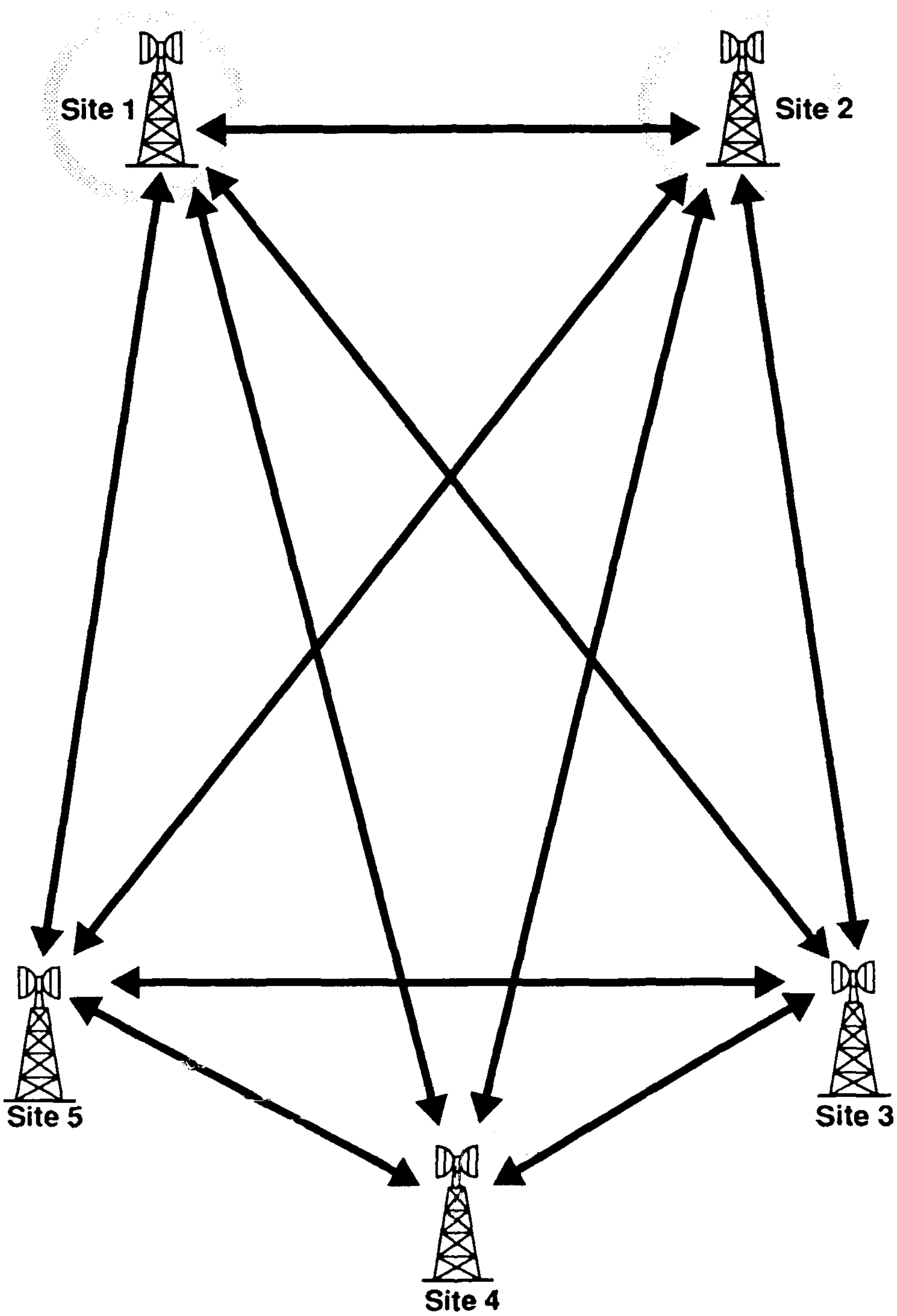

Figure 2. Architecture of closed multi-site two-way video and two-way audio network.

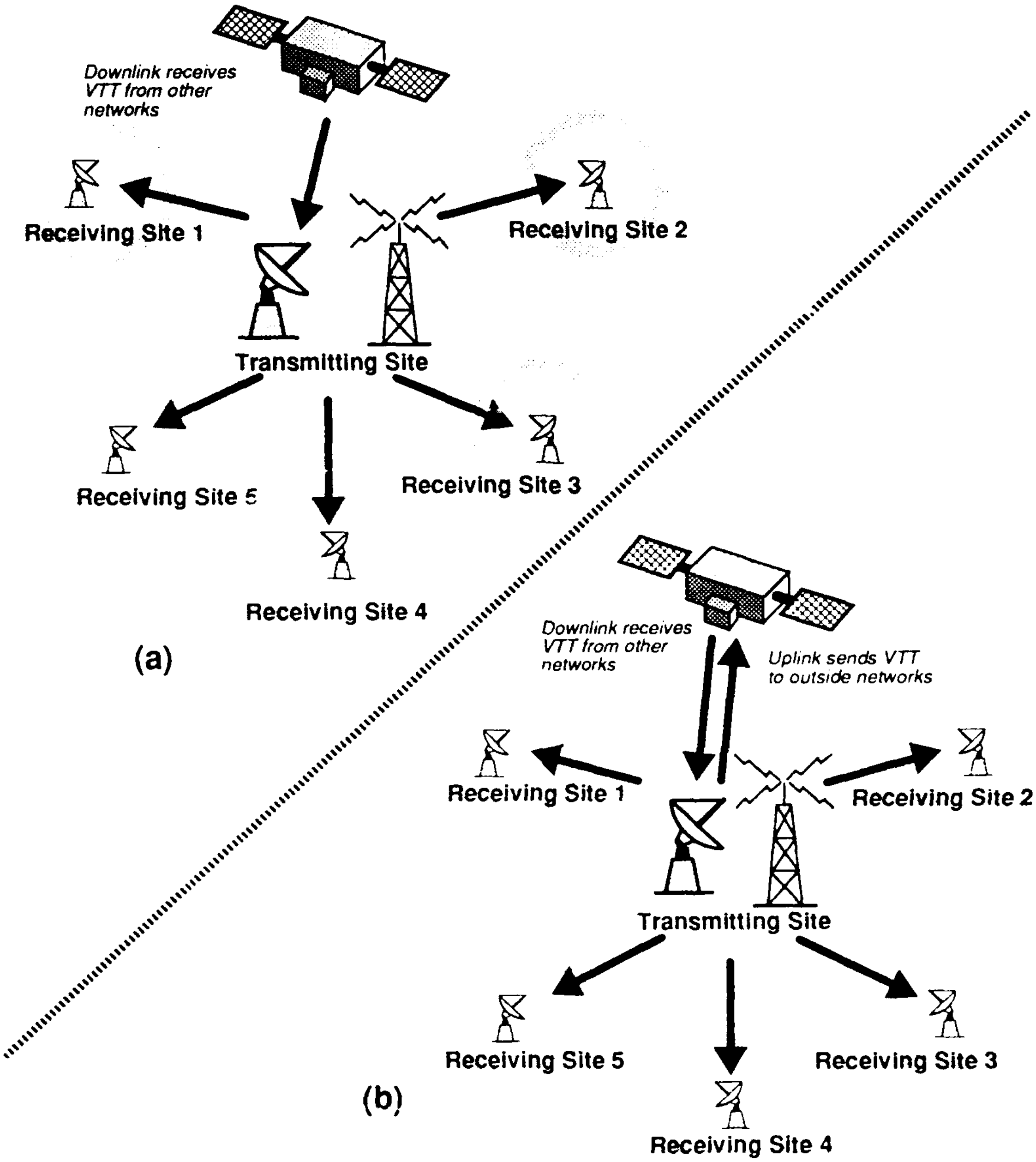

Figure 3. Architecture of open onw-way video network with (a) one-way link to external network and (b) two-way link to external network.

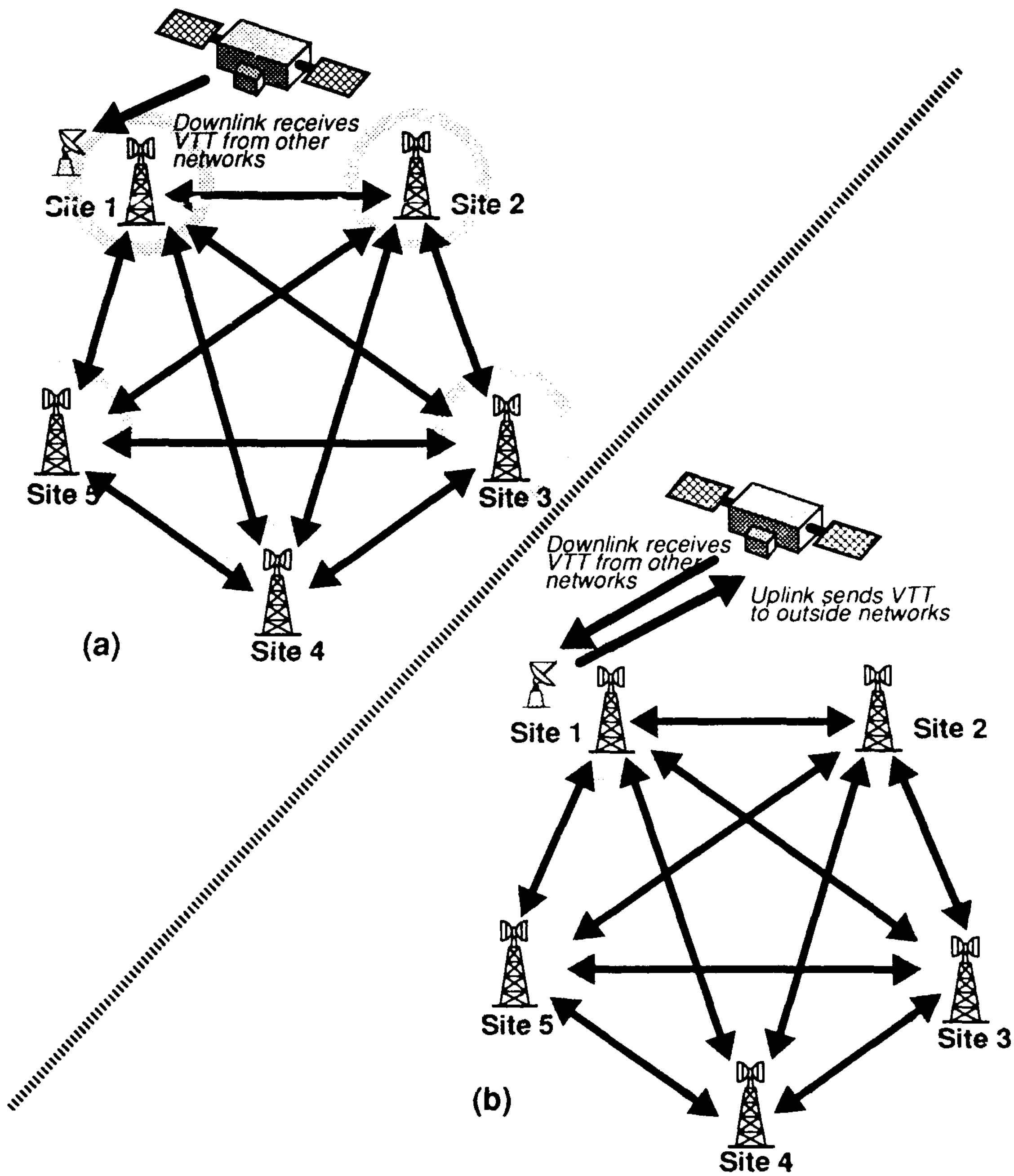

Figure 4. Architecture of open multi-site two-way video network with (a) one-way link to external network and (b) two-way link to external network.

Closed Networks

Overview

Closed networks operate autonomously. Network users may lack the need to communicate externally, the necessary hardware or monetary resources, or local policy or lack of contractual agreement may preclude communication. This section discusses two common closed network architectures: (1) one-way network and (2) two-way network.

One-way Networks

Figure 1 shows the architecture of a typical one-way closed network. Cost is a major factor in the development of such networks as only the site where training originates requires video transmitting equipment. Microwave transmission sites can cost in the range of $100,000 to $200,000, and satellite uplink facilities range from $500,000 to $1,000,000 per site. Receiving sites only require relatively simple and low cost equipment ; depending on type of technology employed, the cost of a receiving site ranges from approximately $800 to $50,000 (U.S. Congress, 1989). These systems may include a telephone-based audio link from receiving sites back to the source; the source may manage calls with a switchboard or use an audio bridge to handle many calls.

One-way networks are simple and relatively inexpensive. Examples of one-way networks observed during the field survey are the U.S. Army Satellite Education Network (SEN) and the Westcott Communications networks (ASTN and LETN). Table 1 shows that these sites do not uplink or downlink VTT programs from other networks, and they use one-way video links for transmitting to VTT classrooms. The EDS network also uses this architecture, but is a conferencing rather than a training network.

Consider the following characteristics of SEN: receivers are dispersed over the entire continental United States, training staff is located at a single site, and the hours of operation are limited. When there are many students who need to receive training, and they are also spread over a wide area, then one-way video transmitted by satellite is a reasonable choice for the VTT medium. The cost of a return video signal would be difficult to justify on a large system, unless there were exceptional needs to be met. Furthermore, simultaneous video feedback from a large number of locations is not useful to an instructor. If it is possible to have the training staff at a single location, as is the case with SEN, then the closed one-way video network is highly efficient. However, there may be various drawbacks to centralization (e.g., the change in time zones across the United States limits the hours of operation during which the system can operate at peak efficiency). This drawback may not be a problem if the number of training hours per day is limited. The Westcott network has many features in common with SEN (e.g., centralized training staff providing specialized training to a widely dispersed student body).

One-way networks often devote considerable effort to creating high-quality video productions which make good use of the video medium and which presumably reduce student questions. This can lead to a requirement for substantial technical staffs to handle lighting, camera operation, and other aspects of video production.

Two-way Networks

Figure 2 shows the architecture of a typical two-way network. The Navy Electronic Schoolhouse Network is the largest closed two-way network of which we are aware, though it covers a smaller geographic area and has fewer nodes than the one-way networks surveyed. Two-way networks are fairly commonly used to link three or four rural schools via microwave or land lines. Each site on the network needs to both transmit and receive, and the network must have sufficient bandwidth to carry information among sites; digital compression techniques are often used to reduce bandwidth requirements. (The Navy Electronic Schoolhouse Network also encrypts its signals to assure security.) In cases where only a small number of locations need to be connected and where distances are small, then microwave transmission of analog signals is often the transmission medium of choice. However, microwave transmission is distance sensitive, and so its use is limited to relatively small systems.

The training delivered by a two-way system is likely to be adapted from training developed for the live classroom with very little change from its original form. Instructors for the Navy Electronic Schoolhouse use curriculum, manuals, and visual aids with little or no change from the material normally used for Navy training in the established live classroom training. Teachers on VTT systems of this type use curriculum, teaching styles and materials similar to that used in the usual live classroom.

Open VTT Networks

Overview

Open network are linked to other networks. These come in various forms, as illustrated in Figures 3, 4, and 5. They downlink VTT programming from external networks, and may be able to uplink programs as well. Figure 3 shows an open one-way video network with (a) one-way link to external network and (b) two-way link to external network. Figure 4 shows an open multi-site two-way network with (a) one-way link to external network and (b) two-way link to external network. Figure 5 shows an open hybrid network consisting of a mixture of internal one-way and two-way video links. Open networks are widely used in public education. The design allows institutions to share programming and extend instructional resources.

Many open networks use the Instructional Television Fixed Service, which is described in greater detail below. In recent years, it has become apparent that there is a trend toward the integration of one-way and two-way VTT systems. This trend, and some of its implications, are also discussed below.

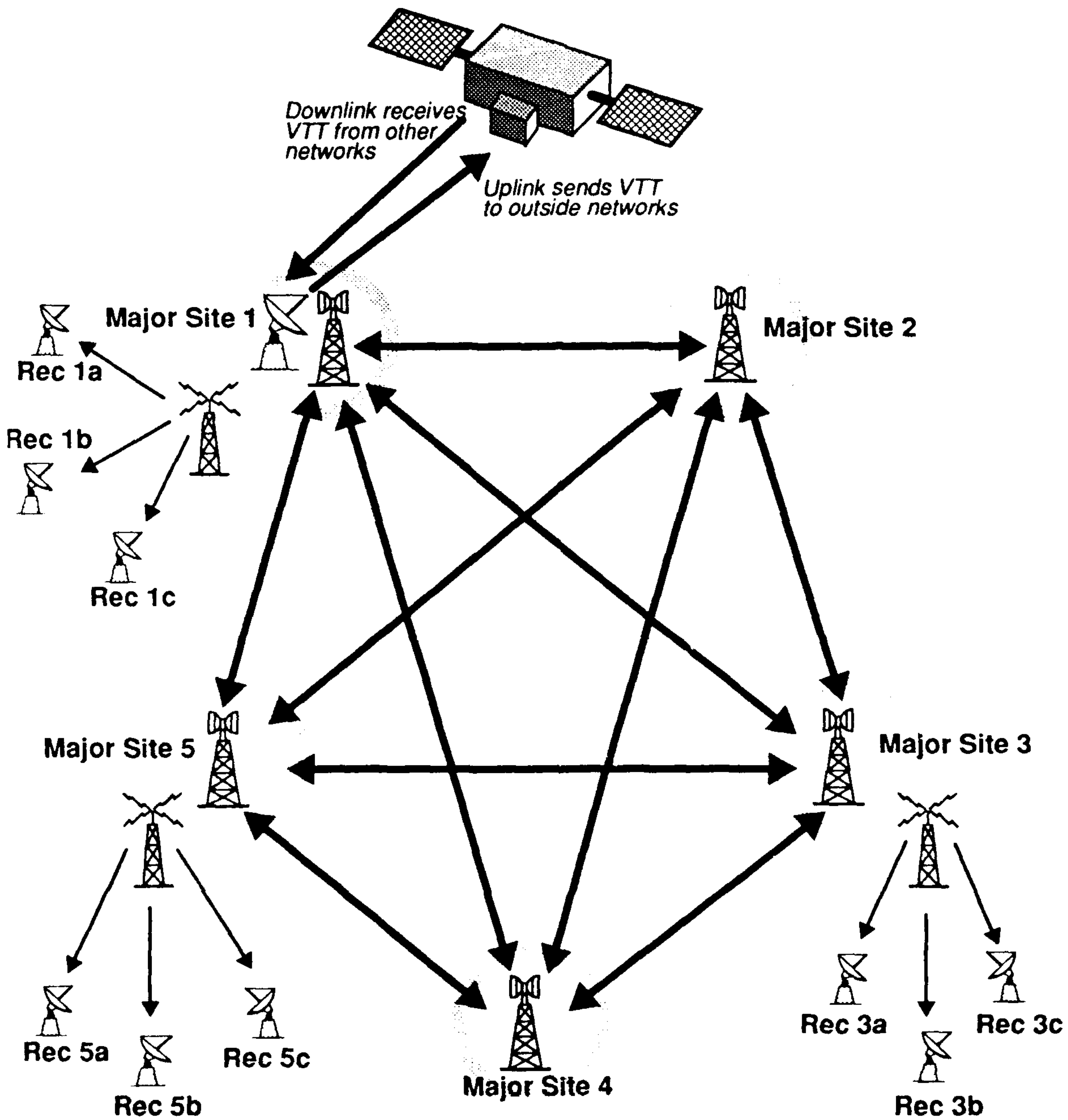

Figure 5. Architecture of open hybrid network with mixture of internal one-way and two-way video links.

Instructional Television Fixed Service

The Federal Communications Commission has set aside a band of frequencies to be used only for transmitting educational programs. This band is commonly used by a microwave system called the Instructional Television Fixed Service (ITFS). ITFS uses omnidirectional microwave antennas to transmit VTT to sites within a radius of about 20 miles of an antenna. Antennas may relay programming or be co-located with the site at which programming is originated. ITFS is also commonly used to relay programs originating from outside the particular ITFS network. ITFS is often delivered to business or government offices whose employees receive training at the work site.

ITFS is a convenient and relatively economical way to disseminate VTT programming to clients within an urban community. A university sending VTT to remote sites by another means can easily transmit locally via ITFS, or programming from cable or satellite can be downloaded and relayed to the local receiving sites via ITFS. Receiving sites require a relatively inexpensive antenna and converter, and return audio is typically provided via telephone lines.

Most of the universities surveyed used ITFS within their VTT system. For example, SDSU uses ITFS to transmit programs via PROFNET. Washington State University links five campus sites with a two-way microwave network and uses ITFS to relay programming to businesses in the Spokane area.

Integrating One-way and Two-way VTT Systems

Two-way VTT networks enable considerable interaction among students at different sites, allow classes to be originated from any site, and generally require less adaptation of curriculum and instructional methods. They also support decentralization, as any site can originate as well as receive programming. However, fewer sites can be simultaneously active in a two-way network than in a network consisting mainly of receive-only sites. In addition, two-way networks cost more to establish and operate than one-way networks.

Because of the relative advantages and disadvantages of the two different types of networks, many systems integrate both to some degree in hybrid networks, as shown in Figure 5. A hybrid network may only need a few sites with two-way capability. Prime candidates would be sites where instructors and training resources are concentrated, where instruction requires high levels of interaction, or where users who need to teleconference are located.

Washington State University's network is a good example of hybrid architecture, which integrates several different VTT systems into its overall structure. The network links five campuses with two-way VTT, uses ITFS to relay training to the business community in Spokane, and uses a satellite downlink to receive agricultural programs for the local farming community.

Consortia

VTT consortia extend the reach of individual networks and are generally formed to share facilities, programming, and VTT users. Thus, VTT originators can reach a larger market, do not have to produce as many programs in-house in order to offer a variety of courses, and can

concentrate on high-quality VTT courses in their areas of instructional expertise. VTT users benefit from increased instructional diversity and quality. Coordinating the activities of several institutions, which are likely to be operating under several different sets of laws and policies, is complex (England, 1989).

A consortium is usually formed for some particular purpose. For example, there might be a need to raise the quality of secondary instruction in a rural area extending across state boundaries, or a requirement to produce specialized engineering courses which draw on expertise diversely located. Most, if not all, of the universities visited during the survey were involved in one or more consortia. The consortia described below were associated with one or more of the VTT sites surveyed.

Many consortia grew out of the Star Schools Program. Congress created this program in 1988 to enable U.S. education to provide advanced courses in mathematics, science, and foreign languages. Three of the four projects approved for implementation at the beginning of this program provide VTT via satellite: Satellite Educational Resources Consortium, TI-IN United Star Network, and the Midlands Consortium. The Star Schools funding for these projects has made it possible for there to be cooperative efforts among educators of different states to provide quality education to schools through VTT. One of the sites visited during our survey has taken a leading role in the Midlands Consortium.

Midlands Consortium

The Midlands consortium is a partnership of five universities who have joined to produce VTT for secondary education. One of the sites surveyed, Oklahoma State University (OSU), is taking a leading role in this effort. Curriculum and hardware, which had been developed by OSU's Arts and Sciences Telecommunications Services (ASTS), served as the foundation for building this network. Each member of the consortium is an independent provider of VTT programs. Each state influences management within its boundaries so that the consortium functions as four networks that are interconnected, rather than functioning as a unified network.

National University Teleconference Network

The National University Teleconference Network (NUTN) is a consortium of over 250 colleges and universities whose purpose is to distribute and market videoteleconference programs. NUTN headquarters is at Oklahoma State University at Stillwater. NUTN provides about 100 short (1 or 2 days) courses per year. About 60 of these are shown for a fee, with the remainder available without cost. Programs are noncredit courses in such subjects as project management, business ethics, dealing with alcoholism in the workplace, AIDS and the college community, black history, and caring for the grieving child. Programs are produced by NUTN members or outside groups and are bought by the consortium for distribution on NUTN. Non-member clients may purchase the right to view NUTN programs.

National Technological University

The National Technological University (NTU) is a consortium formed as the result of collective efforts by industry and by the Association for Media-Based Continuing Education for

Engineers (AMCEE). Two of the sites surveyed (Oklahoma State University and The University of Wisconsin-Madison) are among the 29 NTU participating universities. There are over 240 NTU receiving sites. The NTU receiving locations are generally worksites where there are a number of engineering personnel who wish to receive NTU courses. Courses are credit and noncredit courses related to engineering. Programming is aimed at the professional engineer who has at least a bachelor's degree, and who wishes to advance his or her knowledge or keep current with advancing technology. Some courses last only 1 or 2 days, but many last a semester and lead to graduate credit in engineering. A sampling of courses listed in the 1987-88 bulletin (National Technological University, 1987) includes software engineering, compiler construction, robot vision, expert systems, solid state device design, and quantum electronics. NTU offers seven different programs leading to the Master of Science Degree.

AG*SAT

AG*SAT is still in the process of being established. It will eventually be a network similar to NTU, but with a focus on agriculture rather than engineering. Two of the Universities surveyed (University of Wisconsin and Washington State University) had plans to participate in AG*SAT.

Conferencing Networks

The following observations are made cautiously, for we surveyed a small number of conferencing sites at organizations with large assets. Conferencing networks can have any of the architectures already described for VTT networks. For example, the EDS conferencing network uses one-way video with two-way audio, the DCTN uses two-way video, and ABC, Inc., uses a hybrid network with both one-way and two-way video. What conferencing networks have in common is simply that they are used primarily for conferencing rather than training.

Conferencing networks can be used for VTT, and in the locations we surveyed sometimes were. However, a conferencing network typically differs from a training network in certain predictable ways (e.g., (1) its users tend to be senior management or technical professionals, (2) rooms are generally nicer [e.g., carpeted, soundproofed, and with other amenities], (3) rooms tend to be smaller and set up for video to capture a small group, (4) scheduling is oriented toward short business meetings rather than lengthy courses, (5) large two-way conferencing networks are more complex and expensive, (6) conferencing sites do not usually have resident staff for developing and delivering VTT programs, and (7) equipment is controlled by system users rather than technical support personnel).

VTT classrooms more often than conferencing rooms are remotely controlled by technical support personnel. This may be because VTT is a logical evolution of instructional television, which tends to follow this pattern. The conferencing rooms we observed generally had controls that enabled a relatively untrained person to control cameras, monitors, and audio. This does not necessarily mean that fewer people are involved in conferencing than training. The equipment is complex and sophisticated and requires monitoring and technical support by people who are not directly involved in video production.

COMMON PROBLEMS OF VTT SYSTEMS

The most consistently reported problem with VTT systems was poor quality audio. A typical assessment of the problems on a VTT system appears in the *Vermont Interactive Television Evaluation Report* (Bassage, Guthiel, Miller, Thompson & Wilson, 1988):

> Most of the problems were with the quality of the *audio*. There were too few *microphones* to pick up all participants in group discussions. More important, the person speaking often heard a very distracting *echo effect*.

Other sites reported problems with static on phones, audio feedback, fluctuations in volume, insufficient microphones, and echo. There is a technical aspect to the audio problem, and there is also an aspect having to do with the amount of information carried by audio which affects the perception of the relative severity of the problem. The technical problem is that sound feeding into microphones from various sources distorts and interferes with the audio signal. The more live microphones on the system, the more likely that severe audio problems will occur. One of our survey participants suggested that five sites with open microphones were the maximum a system could handle. But if there are too few microphones, or if microphones are difficult for students to access, then interactivity is reduced. The audio problem is exacerbated by extraneous noise in a VTT classroom. One site surveyed had a wall air conditioner in the room, and the only way that the room could be cooled was to cool it down before class. While the class was in session, the air conditioner had to be turned off.

The other aspect to the audio problem is that the audio signal carries much of the critical information that a student needs. Thus, the perceived severity of the problem is related to the student's need for the information. Consider that if the video signal is bad, then the student still can follow a lecture via the audio signal; on the other hand, without audio, the student cannot follow instruction even if the video transmission is good.

Weather and microwave signals can interfere with satellite transmission. A Washington State interviewee stated that in part of his state where weather is a severe problem, Ku-band signals often experience interference. In other areas, external microwave signals cause interference, particularly with C-band transmissions.

VTT networks often operate over large geographic areas, and problems may arise from having to operate within different governmental and legal jurisdictions. For example, a teacher accredited to teach in a state where a VTT course originates may require an exemption from licensing requirements in another state where the course is received.

DISCUSSION

Some Research Issues

The survey revealed little research effort directed at systematically evaluating VTT, although managers at many sites had collected some data and drawn some conclusions. Most site managers had concluded that their system effectively delivered training to people who would not otherwise receive it (e.g., to professionals at or near their work site. Often there were reports of deficiencies

in the system, such as poor audio quality). Certainly, a main area to investigate regarding the equipment used for VTT is to find a reliable and economic means of providing good audio.

One of the results of some survey questionnaires was that students and instructors wanted more interactivity (e.g., Johnson, 1990; also Simpson, Pugh & Parchman, 1990). On the other hand, SDSU recently reported that student responses to a survey questionnaire indicated that interactivity is not rated as highly important (Behm, 1990). On the basis of these preliminary findings, SDSU will explore the use of videotape distribution as a means of providing distance education.

Issues related to the importance of different types of interactivity need to be explored through further research. Are there certain groups of students or certain types of course material that require an interactive mode of presentation? Is interaction with the instructor as important as interaction with other students or with some of the course materials? In what way is the video component an important part of any of these interactions? Answers to some of these questions would provide a basis for deciding when and how VTT should be used.

A final research issue involves the addition of technologies. There generally is not research to determine the instructionally optimum system. New videographic and audiographic technologies are being developed, but not in the VTT context. There is a need to determine the optimal utilization of these newer technologies.

Growth and Evolution of VTT Networks

There is a clear trend toward the expansion of VTT networks, as evidenced by the proliferation of systems as described in reports such as *Linking for Learning: A new course for education.* (U.S. Congress, Office of Technology Assessment, 1989). The trend was evident from our survey; personnel at several sites surveyed mentioned expansion plans. Network expansion may take a variety of forms (e.g., increased number of transmitting or receiving sites or channels, greater number and/or variety of courses, improved equipment, more clients/students). One-way video networks can add new receiving sites at fairly low cost. Two-way video network expansion is more costly and complex and may require adding channels to the system.

Generally, VTT providers want to increase geographic coverage at minimum cost and VTT students want to obtain more courses. One way to satisfy both objectives is for the network to participate in a consortium. Consortia are powerful means to leverage limited resources. They allow a small network to tap into others and eliminate the requirement for the network to oversee all of its own productions. Students are able to select from a wide variety of courses. Clearly, there is also a trend for the growth of these cooperative ventures. The future will witness further increase in the size of individual networks and the number of consortia. One sample indicator of this growth is that NTU has increased from a network of 14 receiving sites in 1984 to 240 sites at the end of 1990. Another is the recent formation of AG*SAT.

The number of small-scale joint efforts is also likely to increase. For example, Washington State University is exploring the possibility of joining with Oregon in a two-state VTT system.

Some survey participants plan to increase the number of channels, and this appears to be a likely trend for the future.

Compressed video technology has been steadily improving and its cost has been falling. This, along with the desire to increase the number of channels on a network, will probably increase the use of compressed video. For example, Washington State University's WHETS system is being converted to compressed video to increase the number of available channels within the same bandwidth used by the current system.

It seems reasonable that factors prompting consortia would also encourage joint efforts between organizations that use videotelecommunications for training and those that use it for conferencing. The survey provided no evidence to support this notion. Conferencing networks such as DCTN are used very little to deliver training; in general, conferencing networks specialize their facilities, staffs, and scheduling procedures in ways that are incompatible with training efforts. Many training networks are used to some degree for conferencing, although their facilities, staffs, and scheduling procedures are not ideal for business or technical conferencing. Thus, we do not expect that there will be a tendency toward joint efforts in training and conferencing in the future.

CONCLUSIONS

Several types of VTT networks exist, including closed networks with one-way video, two-way video, and hybrid forms containing both. Open networks consist of these forms with links to outside networks.

Most of sites surveyed reported that their systems were effective and were performing well, with only minor problems to be resolved. One seemingly universal technical problem is unsatisfactory quality sound.

It appears that networks spanning large geographic areas tend to use one-way satellite transmission. Networks having many nodes tend to use either one-way video or hybrid forms of transmission. The number of exclusively two-way video networks is presently small, but growing.

There is a well-established trend for networks to join consortia to share resources. The planning of any large scale VTT network should include provisions to allow for network compatibility with other systems, which may be interconnected in the future.

It is more expensive to build a video network with two-way capability than one with one-way capability. However, presenting effective training with a one-way network may require a greater amount of training preparation; the differences have not been established empirically. There are probably limitations to the types of training topics that can be covered effectively with VTT, but those limitations are not well understood. Research in a controlled environment could provide answers to some of these practical questions.

There are several less costly means of remote instructional delivery than VTT that may be considered as competing alternatives. Some examples are videotape, interactive videodisks, and audiographics. The strengths and limitations of these media are not well understood and should be further explored in a distance education context to develop guidelines for the most cost-effective distance education systems of the future.

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APPENDIX A

NPRDC TELETRAINING *FIELD* SURVEY INTERVIEW QUESTIONNAIRE

APPENDIX A:

NPRDC Teletraining Field Survey
Interview Questionnaire

Location ______________

Date ______________

Interviewer ______________

Interviewee Name(s)	Title	Phone

Navy Personnel Research and Development Center

Code 15

San Diego CA 92152-6800

Henry Simpson: 619-553-7790

H. Lauren Pugh: 619-553-7787

Steven Parchman: 619-553-7794

Instructions to Interviewers

1. Obtain the following from the interviewee(s):

   a. Business card

   b. Any available documentation on the system you are investigating

   c. Copies of any technical reports or articles the interviewee offers to make available

   d. Any other documentation--written, video, or other--that may be useful

2. The questions in this protocol are provided for guidance. Try to answer them but if they are inapplicable or inadequate, make notes on the blank pages.

3. Make drawings to illustrate the interviewee's responses, if possible.

System Description

1. Media Used:

	1-Way	2-Way	Other
Video	____	____	____
Audio	____	____	____
Phone	____	____	____
FAX	____	____	____
Computer	____	____	____
Other	____	____	____

Comments:

2. System Architecture:

	Number	Locations
Uplinks	____	____
Downlinks	____	____

Links to other systems (describe):

System Configuration (draw/describe, e.g., star, tree, 2-point, etc.):

3. Signal Transmission Links:

Satellite____ C-band____Ku-band____ Other____

T1____ Fiber____ Copper____

Microwave____

Cable____

CCTV____

Hybrid____(describe below)

Other____

Comments:

4. Analog/Digital:

Analog____

Digital____ Data rate (Kbps)______ Frame rate (fr/sec)____ Codec ____

Comments:

5. Security:

Open system____

Encryption____ Equipt used______________________________

Privatization____ Equipt used_________________________________

Other_____ Equipt used______________________________

Comments:

6. System Usage Schedule:

Number of classes/year (total)____

Number of operational hours/year____

Number of students/year____

Number of students/course____

Days of operation (circle): Mon Tue Wed Thu Fri Sat Sun

Hours of operation________________

7. Originating Classroom Equipment

	Number	Description (e.g., brand, size, etc.)
Video Cameras	____	________________________________
Video Switches	____	________________________________
Video Monitors	____	________________________________
Audio Mixer	____	________________________________
Microphones	____	________________________________
Sound Cond.	____	________________________________
FAX	____	________________________________
Computer	____	________________________________
Telephone	____	________________________________
VCR	____	________________________________
Other	____	________________________________

Comments:

8. Originating Classroom Floor Plan (drawing)

9. Receiving Classroom Equipment

	Number	Description
Video Cameras	____	________________________________
Video Switches	____	________________________________
Video Monitors	____	________________________________
Audio Mixer	____	________________________________
Microphones	____	________________________________
Sound Cond.	____	________________________________
FAX	____	________________________________
Computer	____	________________________________
Telephone	____	________________________________
VCR	____	________________________________
Other	____	________________________________

Comments:

10. Receiving Classroom Floor Plan (drawing)

11. System Design Process:

Please describe the process followed in designing your system.

How did cost influence your design?

Instruction/Training

12. Curricula:

Courses Offered (list):

____

____

____

____

____

____

____

Number of **different** courses offered____

Typical length of course (hours)____

What **selection criteria** are used to decide which courses to deliver remotely (e.g., demand, course content, cost, lecture-based, etc.):

Please rank the criteria in terms of importance on a scale from 1-5, where 1 is "not important", 3 is "somewhat important", and 5 is "highly important".

Criterion	Ranking
____________	___
____________	___
____________	___
____________	___
____________	___
____________	___

Most successful course? Why? ______________________________

Least successful course? Why? ______________________________

Who prepares/adapts classroom materials for use in distance training?

____

How do these materials differ from those used in live instruction?

Does the delivery medium limit the choice of curricula? If 'yes', how?

Describe any problems that you have had in **accrediting, conferring degrees, licensing, or otherwise certifying** students.

How might these problems be overcome?

13. Staff Qualifications:

Instructors____

Curriculum Developers______________________________________

Facilitators____

Proctors____

How are are staff members selected?

How are staff members trained?

Logistics/Support

What procedures are used for administering/scoring tests?

Locally:

Remotely:

What training support is provided (e.g., facilitator, instructor)

Locally:

Remotely:

What technical support is provided?

Locally:

Remotely:

What other logistic support is needed?

Locally:

Remotely:

Research Issues

14. Evaluations

Describe evaluations that have been performed in the following areas:

Training Effectiveness:

Instructor/student attitudes:

Cost Effectiveness:

15. Ongoing Research

Please describe any ongoing research at this facility.

Research Objectives:

Independent Variables:

Dependent Variables:

Relating to the incorporation of graphics/visuals?

Who (investigators) is performing the research?

What further research do you think is needed?

Miscellaneous

How are the capital costs for the system paid for?

How are operational costs distributed?

Is cost effectiveness tracked? If so, how important is it to this organization?

What groups (local business, military, etc.) are served by this system?

Is this system used for purposes other than training? If so, to what degree?

What are the major lessons that you have learned in operating this system?

What are the most serious shortcomings of the system?

What plans do you have for developing this system in the future ?

APPENDIX B

GLOSSARY

GLOSSARY

Analog signal: A signal that carries information in the form of relative levels (e.g., amplitude) rather than discrete units (e.g., digital bits). Audio and video information are commonly represented in terms of amplitude or frequency modulation levels of an underlying carrier signal. The levels of amplitude or frequency vary in magnitude on a continuous scale corresponding to values of magnitude of some feature (e.g., pitch or brightness) represented by the signal.

Audiographics: A technology that allows graphics information to be communicated between computers simultaneously with real-time, two-way audio communication. Audiographics technology permits the computer interaction and audio communication to be transmitted over a single commercial telephone line.

Bandwidth: The width of frequencies in a communication signal that is required for the transmission to be completed without distortion. The amount of bandwidth required for a signal is directly related to the amount of information being sent.

C-band: A satellite communications signal that operates at 6 gigahertz (billion cycle per second) for the uplink and 4 gigahertz for the downlink.

Codec: COder-DEcoder, a device programmed with an algorithm that enables communication in a fraction of a signal bandwidth required by conventional analog video. At the transmitting end, the codec transforms the analog video signal to digital form and applies a compression algorithm to reduce its bandwidth. At the receiving end, the digital signal is decoded and reconverted to analog form for display. Refer to definition of Compressed Video.

Compressed video: Video produced using a codec bandwidth compression device. The codec digitizes the signal and follows a compression algorithm to reduce the amount of bandwidth required to carry the signal by an order of magnitude as compared with conventional analog video. Refer to definition of Codec.

Digitized signal: A signal that carries information in the form of discrete units (e.g., bits) rather than relative levels (e.g., amplitude). Features (e.g., pitch or brightness) represented by the signal take on discrete values. The information can be represented, transmitted, and received in unambiguous numerical form, and can readily be processed using computer-based digital compression techniques.

Downlink: A receiving antenna for a satellite signal. Sometimes used to designate a facility that has such an antenna.

DS-3 line: A communications line capable of transmitting a signal carrying information at a rate of 45 megabits per second.

Duplex: Used to designate a system that has a two-way signal. For example, a system with duplex audio uses two-way audio communication. A full-duplex system has both two-way audio and two-way video communication.

Encryption: A method of scrambling a signal so that it cannot be intercepted by non-privileged parties. The most sophisticated encryption such as used by the military must work with a digitized signal.

ITFS (Instructional Television Fixed Service): A band of microwave frequencies has been set aside by the FCC to be used only for transmitting educational programs. This microwave capability is known as ITFS. ITFS is an omnidirectional microwave capability that allows transmission of VTT (Videoteletraining) to sites within a radius of about 20 miles of the transmitter. The transmitting site may be the originator of the VTT program, or it may relay programs that have been downloaded from satellite. The ITFS system spreads VTT programs among clients who could not otherwise get the satellite programs.

Ku-Band: Designation for satellite signals operating at 14 gigahertz (billion cycles per second) uplink and at 12 gigahertz downlink.

Lavalier microphone: A microphone that can be clipped to a speaker's lapel.

Star Schools Project: The Omnibus Trade Bill, passed in 1988 (created the Star Schools program) to provide U.S. education with the means to provide advanced courses in mathematics, science, and foreign languages.

T1 line: A communications line capable of carrying information at a rate of 1.544 megabits per second.

Uplink: A transmitting antenna for a satellite signal. Sometimes used to designate a facility that has such an antenna.

VTT (Videoteletraining): VTT is the technology used to communicate training between locations using video and audio. A VTT network differs from a videoconferencing network in that the communication is predominantly for a training or educational purpose. This difference in purpose has implications for the technology and management of facilities used for VTT.

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